REPORT ON PHYSIOLOGY.

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In presenting the first of a series of reports on the progress of physiology, it seems desirable to indicate briefly the object which will be had in view, as well as the plan to be followed in their preparation.

The necessary limits of time and space will of course render it impossible to give a complete *résumé* of all the work done each year in a science so extensively cultivated as Physiology. Nor is it necessary to do so, for the voluminous annual reports published in Germany* are so complete as to leave nothing to be desired in this direction. These reports give short notices of all the physiological work published during the year in all the languages of Europe, and are invaluable for any one who desires to ascertain the present state of knowledge in regard to any particular point in physiology.

Instead of attempting any such exhaustive treatment of the subject, a certain number of special questions will be selected to be discussed, somewhat critically, in the light thrown upon them by recent investigations. Each report will, therefore, be an attempt to present in a concise form the results arrived at in several of the most important departments of physiology. It is hoped that this course will be in accordance with the best interests of the readers of the Journal.

Absorption of Albuminoid Substances.

Bruecke.—Beiträge z. Lehre v. d. Verdauung. Wiener Sitzuungsberichte, Bd. 37, 1859. Ueber d. Peptontheorien u. d. d. eiweissartigen Substanzen. Weiner Sitzungsberichte, Bd. 59, 1869.

Diaconow.—Ueber d. Verdauung d. Eiweissstoffes in künstl. Magen. u. Pankreassaft. Med.-Chem. Untersuchungen von Hoppe Seyler. Heft. ii., 1867.

Voit und Bauer.—Ueber d. Aufsaugung im Dick und dünndarm. Zeitschrift für Biologie, Bd. 5, S. 536.

Fick.—Ueber die Schicksall d. Peptone im Blute. Pflüger's Archiv, v. 40.

Eichhorst.—Ueber die Resorption d. Albuminate im Dickdarm. Pflüger's Archiv, iv. 571.

Since the discovery of the power of the gastric juice to convert albuminoid substances into so-called peptones, a form in which they are much more diffusible than the albumens from which they are derived, it has been assumed by nearly all physiologists that a change of this sort is a necessary preliminary to absorption, and that unchanged coagulable albumen cannot pass the mucous membrane of the alimentary canal. Prof. Brücke, of Vienna, however, very early called attention to the length of time necessary for the conversion of albu-

* Bericht über die Fortschritte der Anatomie und Physiologie von Henle, Meissner und Grenacher in Göttingen.

Jahresbericht über die Leistungen und Fortschritte in der Anatomie und Physiologie von Rud. Virchow und Aug. Hirsch, unter special-redaction von Dr. E. Gurlt und Dr. A. Hirsch.

minoid substances into peptones, and expressed the opinion that food does not stay long enough in the stomach for the conversion of more than a very small portion of the albumens contained in it. Moreover, the presence of coagulable albumen in the small intestine may be demonstrated. Brücke also alludes to the existence in the pancreatic juice of an albuminoid substance, coagulable by heat, which plays an important part in emulsifying fats. It can scarcely be supposed that the channels which are wide enough to allow the passage of fat drops are impervious to albuminous molecules which serve to emulsify the fat; and if the albumen of the pancreatic juice can be absorbed, there is no reason why the albumen of the food should not be absorbed also.

Diaconow calls attention to the small amount of peptones found in the blood and the intestines, and considers that physiologists are not justified in assuming them to be the only albuminoid substances which are in a form to be appropriated by the organism.

That coagulable albumen can really pass through an animal membrane is sufficiently proved by the occurrence of albuminuria after the injection of white of egg into the veins, the difference between albumen and peptones in regard to diffusibility being one of degree only.

The experiments of Voit and Bauer, and of Eichhorst, consisted in the injection of various albuminoid substances into the rectum of dogs, and determining the amount of nitrogen excreted in the urine and fæces. For this purpose the animals were, in Voit's experiments, kept for several days entirely without food, until the daily elimination of nitrogen had become constant. In Eichhorst's experiments, they were fed on non-nitrogenous food till the same result was obtained. An injection of an albuminoid substance was then made, and any increase in the elimination of nitrogen was considered a proof that absorption through the large intestine had taken place. In order to exclude the hypothesis that anything like digestion could take place in the rectum, the fluids of the large and small intestine were carefully tested in regard to their action on albuminoid substances, and were found to possess no digestive power whatever. The experiments showed that the following substances were absorbed through the mucous membrane of the large intestine: juices of meat, milk, solution of myosin, white of egg mixed with salt, solution of gelatine and Liebig's meat extract. On the other hand, simple white of egg, solution of syntonin and blood serum were not thus absorbed. The juice of meat was found to be quite as easily absorbed as peptones, which is an additional proof that no digestion occurs in the large intestine.

Relying upon these experiments, Voit expresses the opinion that only the albumen, which is absorbed unchanged, is used for the repair of organs and tissues, and that the peptones which are absorbed are probably rapidly decomposed. Otherwise we must suppose that the peptones derived from the albumens of the food are converted, after absorption, into the albumens of the body, a process not in accordance with the economy of force which we see usually manifested by Nature.

Fick adopts the same view, and supports it by the following experiment. Albumens and peptones are injected into the jugular vein of rabbits whose kidneys have been extirpated, and at different intervals the blood is examined for urea. The injection of albumens is not fol-

lowed by any important increase of urea in the blood, while the peptones cause a very marked increase, which is proportional to the time elapsing between the injection and the examination of the blood.

Nutritive Enemata.

Leube.—Ueber die Ernährung der Kranken vom Mastdarm aus. Deut. Arch. für Klin. Med. Bd. x. S. 1–54.

Leube.—Ueber die Anwendung des Pancreas-glycerinextractes zur Ernährung der Kranken vom Mastdarm aus.

The experiments described above prove the possibility of nourishing the body by nutritive enemata even when no digestion can be supposed to take place in the rectum. The results will, of course, be much more certain when such a digestion does occur, and this Leube proposes to effect by mixing with the enemata a small amount of the glycerine extract of the pancreas prepared according to the method of von Wittich (*Pflüger's Archiv*, ii. 193). The glycerine extract of the gastric mucous membrane would probably be quite as effective.

Digestion of Starchy Substances.

Meyer.—Ernährungsversuche mit Brod am Hund und Menschen. Zeitschrift für Biologie, vii. p. 1.

Sonsino.—On the Physiological Dyspepsia for starchy Food in Infancy. Practitioner, li. 155.

Schenk.—Uber die Vertheilung des Klebers in Weizenkorne Anatomische Untersuchungen, Wien, 1872.

The relative nutritive value of bread of different sorts has been investigated experimentally by Meyer. The experiments were made on a young man of strong and healthy constitution, and the bread used was of four different sorts.

I. Rye bread (without bran) prepared by the Horsford-Liebig process.

II. Munich rye bread made from bolted rye meal, with the addition of coarse wheat flour, raised with leaven.

III. White wheat bread raised with yeast.

IV. North German black bread (Pumpernickel), made from coarse, unbolted rye meal, raised with leaven.

Each sort of bread was used as food for four consecutive days, being, with the exception of a daily allowance of 50 grammes of butter and two litres of beer, the only food taken during that time.

Between each series of days, thus devoted to experiment, several days or weeks intervened, during which the individual regulated his diet according to his inclinations.

The solid constituents, the nitrogen and the mineral substances, were determined quantitatively for each sort of bread. A similar analysis of the fæces gave the means of determining what proportion of each of these substances was absorbed. The following table gives for each of the four sorts of bread the amount of these substances which appeared in the fæces for every 100 parts swallowed:

Bread.	Solid constituents.	Nitrogen.	Mineral substances.
I.	11·5	32·4	38·1
II.	10·1	22·2	30·5
III.	5·6	19·9	30·2
IV.	19·3	42.3	96·6

It appears, then, that the bread which furnishes the greatest amount of nutritive materials in a condition to be absorbed is that made of fine wheat flour, and that which furnishes the least is that made of coarse, unbolted rye meal. This result is in direct contradiction to the prevailing views as to the nutritive value of unbolted flour. These views are based partly upon the fact that the feeling of hunger is relieved for a longer time by bran bread than by bread made of fine white flour. The greater and more prolonged distention of the stomach by the former in consequence of its comparative indigestibility is probably the explanation of this feeling. For not only must bran bread be swallowed in greater quantity than white bread in order to obtain an equal amount of nutriment, but it will also remain longer in the stomach because it is less easily acted upon by the digestive fluids.

The superiority of bran bread, as a means of nourishment, was also apparently demonstrated by the experiments of Magendie, who found that a dog fed on white wheat bread died of starvation in fifty days, while another dog fed on black bran bread lived for a long time. In the absence, however, of any statement as to the absolute amount of bread swallowed, this experiment is of no value, for it is quite possible that owing to the less agreeable taste of the white bread the animal did not swallow enough to sustain life.

Besides establishing the nutritive inferiority of bran bread, the experiments of Meyer prove, also, that the large amount of mineral substances present in bread made by the Horsford-Liebig process does not cause the absorption of any greater amount of nutriment. In this respect the previous experiments of Bischoff and Hofmann are confirmed.

The observations of Schenk, on the distribution of gluten in wheat, threw some additional light on the question of the nutritive value of bran. It was observed that, when a transverse section of a kernel of wheat was heated with Millon's reagent, the color characteristic of the presence of albuminoid substances appeared over the whole surface, except in the layer of granular cells, commonly known as gluten cells, lying immediately under the cellulose envelope. Now, since no albuminoid substance is known which is not colored by Millon's reagent, and since gluten obtained from flour shows the characteristic color, it is evident that the so-called gluten cells must be really destitute of gluten. The same result was obtained by subjecting the sections of wheat to the action of a digestive fluid. Here the so-called gluten cells were entirely unaffected, while the starch granules in the interior of the kernel were set free by the solution of the albuminoid framework about them. Although the gluten cells themselves seem to contain no albuminoid substance as tested by Millon's reagent, yet in the central portion of the kernel the albuminoid substances increase from within outwards so that it is still possible that the removal of the bran may involve the loss of some of the most nutritive portions of the flour. It is also probable that the gluten cells, though containing no albuminoid substance, yet really do contain some indigestible nitrogenous material. This would explain the large amount of nitrogen found in bran. This view is also supported by an experiment of Poggiale,* who found that bran passed successively twice through

* Comptes Rendus, 1853, t. 37.

the intestines of a dog and once through that of a cock still contained 3.5 per cent. of nitrogenous substances.

In view of these facts, it is impossible to look upon *all* the nitrogen found in the fæces after a diet of bran bread as derived from digestible albuminoid substances, though, undoubtedly, much of it has this origin, the nutritious substances being carried through the alimentary too rapidly to be wholly digested and absorbed.

Sonsino calls attention to the fact that in an infant the alimentary canal resembles anatomically that of a carnivorous animal, this structure being in accordance with the character of the food on which it lives. Thus the mouth is adapted only for suction and not for mastication. The lips, tongue, pharynx, uvula and soft palate are well developed, while the jaws are small and without teeth till a later period than in any other mammal. The stomach is small and tubular, lying more parallel to the trunk than in adults, the pancreas slightly developed and the small intestine short. These are all indications that the food will stay only a short time in the alimentary canal, and and therefore animal rather than vegetable food should be given. The presence of starch being the principal characteristic of vegetable food, it might naturally be supposed that starch would not be well digested by infants. This view is confirmed by the observations of Guillot, who found in the autopsy of infants a jelly-like substance in the intestines, giving a starch reaction with iodine. Bidder and Schmidt found that the saliva of young animals, man included, has little or no power to change starch into sugar. Schiff confirmed their observations and placed the first appearance of the sugar ferment of the saliva at the period of the first dentition.

Sonsino's experiments showed that an infusion of the pancreas of young cats, dogs and rabbits, has no sugar ferment, though in adult animals the action is very marked. He concludes that "in the early life of man, probably till the beginning of dentition, infants offer a true physiological dyspepsia for starchy aliments, caused by the inactivity of one at least—probably of all—of the humors that concur in the digestion of those aliments."

Hence rice, arrowroot, tapioca, &c. are unsuitable articles of food for infants unless mixed with some substance capable of acting as a sugar ferment. For this purpose the author suggests the use of the glycerine extract of bullock's pancreas.

It is interesting in this connection to notice the custom, said to prevail amongst the peasant women in certain parts of Southern Europe, of moistening the pap in their own mouths before giving it to their children, thus by their own saliva effecting a chemical change which that of their infants would be powerless to produce.

Sonsino concludes with some remarks upon the inability of starchy food to furnish materials for building up the tissues of the body, which is, of course, a very important process in growing children.

Origin of Animal Fat.

Subbotin.—Beiträge zur Physiologie des Fettgewebes. Zeitschrift für Biologie, vi. p. 73.

Hofmann.—Der Uebergang von Nahrungsfett in die Zellen des Thierkörpers. Zeitschrift für Biologie, vii. p. 153.

Toldt.—Beiträge zur Histologie und Physiologie des Fettgewebes. Wiener Sitzungsberichte, Bd. lxii., 1870.

Radziejewski.—Experimentelle Beiträge zur Fettresorption. Virchow's Archiv, Bd. 43, p. 268.

Voit.—Ueber die Fettbildung im Thierkörper. Zeitschrift für Biologie, Bd. v. p. 79.

The question of the origin of animal fat is of great importance as bearing upon the practical problems of increasing by suitable diet the amount of adipose tissue in the body, as in the case of convalescents, and of diminishing the amount of the same tissue in the cases of obesity.

The fact that fat may arise as a product of decomposition of albumenoid substances, has been proved in many ways, but never more satisfactorily than by the following experiments of Hofmann on maggots. The amount of fat contained in the eggs of flies was determined by an analysis of a given number of them. Other eggs were allowed to hatch and develop, the maggots being fed on defibrinated blood. The full-grown maggots were then analyzed, and found to contain about ten times as much fat as the eggs and the food together. The possibility that fat may arise in this way, led to the theory that all the fat in the cells of the body is derived from the decomposition of albumenoid substances in the cells themselves, the nitrogenous products of decomposition passing out by digestion, while the fats remain behind, until, by further decomposition, they assume more soluble forms. On this theory, the fat of the food contributes only indirectly to the deposition of fat in the body by protecting the fat which arises from the albuminoid substances from farther decomposition, and, since the blood never contains any great amount of fat, the fat of the food must be used up as fast as absorbed. This theory is held by Subbotin, who supports it by the following experiments.

I. A dog received daily for a month a certain amount of spermaceti with his food, and an examination of the fæces showed that during the month he must have absorbed at least 100 grammes of that substance. An examination of the tissues showed only a very small amount of spermaceti in the omentum and mesentery, and none at all in the subcutaneous adipose tissue. Subbotin concludes, therefore, that the fat of the body is derived only in a very slight degree from the fat of the food.

II. Emaciated dogs were fattened on food from which one of the normal constituents of animal fat, viz. stearine, had been extracted. The fat in the body, however, contained a normal amount of stearine. This, Subbotin concludes, must have been formed by the decomposition of albuminoid substances.

Similar views are held by Toldt.

According to theory of Radziejewski, fats arise synthetically in the cells, from the soaps formed in the intestine by means of the pancreatic juice and the bile salts acting on the fat of the food. His experiments, however, scarcely sustain his conclusions, and need not therefore be mentioned.

Hofmann denies the force of Subbotin's experiments with spermaceti, because this is a fat abnormal to the body of the animal experimented on, and offers the following experiment to prove that the normal fats of the food may be absorbed as such from the intestines and deposited directly in the tissues.

A dog was kept without food till a sudden increase in the daily ex-

cretion of urea was observed. This, according to the researches of Voit, is an indication that all the fat of the body has been used up. The animal was then fed for five days with large quantities of fat and a small amount of fresh meat. An analysis of the fæces during these five days showed how much of these substances had been absorbed. At the end of the five days the dog was killed, and the total amount of fat contained in the body determined. This fat must have been derived from the decomposition of the albuminoid substances or directly from the fat of the food. The amount of fat which could have arisen from the decomposition of albuminoid materials was calculated on the assumption of Henneberg that 100 grains of dry albumen give rise to 51·4 grains of fat. The following table gives the result of the experiment.

	In five days. Grammes.
Fat absorbed as food	1854·0
" arising from albumen	130·7
" supplied to the body	1984·7
" found in the body	1352·7
" decomposed	632·0

It will be seen that the amount of fat found in the body was ten times as great as could be accounted for, even on the supposition that all the albumens of the food had been changed into fat, proving that the fat of the food must have been deposited directly in the tissues, notwithstanding the difficulty of supposing fat drops to pass through moist animal membranes.

Voit has shown, in experiments made first in 1862, that a dog fed entirely on lean meat excretes in urea all the nitrogen of the meat, but that a portion of the carbon remains behind in the body. This can best be accounted for on the supposition that fat is formed by the decomposition of albumen, and is stored up as such in the body.

In the present state of the question, the most reasonable conclusion seems to be that the fat of the animal body may be, and probably is, formed both from the albuminoid and fatty substances in the food. Whether starchy and saccharine substances can give rise to fats is still an open question.

Glycogenic Function of the Liver.

Flint.—New York Medical Journal, January, 1869. Physiology of Man, vol. iii. p. 315.

Dalton.—Memoirs of N. Y. Academy of Medicine, June 15, 1871. Treatise on Human Physiology, 5th edition, p. 156.

Lusk.—On the Origin of Diabetes. N. Y. Medical Journal, July, 1870.

Bruecke.—Ueber eine neue Methode Dextrin und Glycogen aus thierischen Flüssigkeiten und Geweben abzuscheiden. Wiener Sitzungsberichte, Bd. 63, Abth. ii.

Dock.—Ueber die Glycogenbildung in der Leber und ihre Beziehungen zum Diabetes. Pflüger's Archiv, v. 571.

Weiss.—Zur Statik der Glycogens im Thierkörper. Wiener Sitzungsberichte, July, 1871, Abth. i.

Bock and Hoffmann.—Ueber eine neue Enstehungsweise von Melliturie. Reichert and DuBois Reymond's Archiv, 1871, p. 550.

TIEGEL.—Ueber eine Fermentwirkung des Blutes. Pflüger's Archiv, vi. 249.

BERNARD.—La Glycogenese chez les invertébrés. Revue Scientifique, ii. 401.

Ever since the discovery by Bernard in 1848 that the liver of recently killed animals contains a considerable quantity of sugar, the question of the origin and destiny of this sugar has been a most interesting one for physiologists of all nations. It soon became evident that the formation of sugar in the liver goes on very rapidly after the separation of the organ from the body, and some observers, with Pavy at their head, have gone so far as to declare the formation of sugar to be in all cases a *post-mortem* phenomenon. This view of the case is hardly consistent with the often-repeated observation on living animals that the blood of the hepatic vein contains sugar, while that of the portal vein is nearly or quite destitute of it. The question has of late years been investigated quite extensively in this country.

Flint confirms the observation of Pavy that the fresh liver contains no sugar, but in view of the presence of sugar in the hepatic and its absence in the portal vein, he concludes that sugar is formed in the liver and continually washed out of it by the circulating blood.

Lusk, also, finding in the blood of the right heart from two to four times as much sugar as in that of the jugular vein, concludes that sugar is normally formed in the liver, though its presence cannot be demonstrated in the tissues of the organ itself.

Dalton, on the other hand, analyzing large amounts of fresh hepatic tissue, finds that the liver contains, at least, 0.25 per cent of sugar.

Assuming the theory of Flint to be correct, viz., that the sugar is washed out of the liver as fast as it is formed, it is difficult to conceive how sugar can fail to be found when any considerable portion of fresh liver is subjected to analysis, for the small branches of the hepatic vein must always be filled with blood containing sugar. The failure to find sugar in the fresh liver is probably to be accounted for by a want of delicacy in the reagents or by the use of too small a portion of liver for analysis.

It is acknowledged by all observers that the liver contains, as one of its normal constituents, an anhydrous substance known as glycogen, from which the sugar of the liver is formed. The experiments of Dock, under the direction of Hermann, of Zurich, had for their object to settle the much-disputed question of the origin of glycogen. The animals used were rabbits, and the glycogen determinations were made by means of the method proposed by Brücke. The results showed that starvation for several days causes a disappearance of glycogen from the liver. It can, however, be restored by an injection of sugar into the stomach, but not by the injection of water or albumen. Experiments with fats were not made, as all observers are agreed that the ingestion of these substances does not affect the amount of glycogen contained in the liver. It would seem, then, that the glycogen of the liver is derived exclusively from the carbo-hydrates of the food, a result in accordance with the views of Pavy, but in opposition to those of Bernard, who has recently shown that in the larvæ of certain insects a formation of glycogen takes place when the food consists entirely of meat.

In considering the pathology of diabetes from this point of view,

two hypotheses may be made. Either there is an increased metamorphosis of glycogen into sugar, or the sugar of the food passes directly into the urine, without going to form glycogen. To decide which, if either, of these two hypotheses is the correct one, observations were made on the influence of artificially produced diabetes on the formation of glycogen in the liver. In one series of experiments, two rabbits were starved several days to free the liver from glycogen. On one of them, the floor of the fourth ventricle was punctured, to produce diabetes, and both received an injection of sugar into the stomach. The livers of the two animals were then examined for glycogen. In the liver of the one which had received the "sugar puncture," glycogen was in most cases absent, though present in large amount in that of the one which had not been so treated. It was also found that, after starvation of several days, the sugar puncture produces little or no diabetes, and the question then arises: what becomes of the sugar injected into the stomach, since it appears neither in the urine nor the liver?

In another series of experiments, rabbits were starved for several days as before, then poisoned with curare and kept alive by artificial respiration, while the necessary injections of sugar were made into the stomach. The results showed that poisoning by curare prevents the appearance of glycogen in the liver after the injection of sugar into the stomach, and, moreover, causes the appearance of sugar in the urine, even when no sugar has been injected into the stomach. We find, then, in one series of experiments sugar absorbed from the stomach, appearing neither in the liver nor the urine, and in the other series sugar appearing in the urine, though present neither in the stomach nor the liver. These results plainly indicate that there must be some other organ or tissue of the body besides the liver where the carbo-hydrates of the food can be stored up and from which they may again appear as sugar in the urine. Whether this process goes on in the muscles, as made probable by the experiments of Weiss, or in any other organ, it is evident that the whole question is much more complicated than it appears either from Pavy's or from Bernard's point of view.

To explain the change of glycogen into sugar, the presence of a ferment in the liver or the blood has been assumed. Tiegel (in a series of experiments made under Kühne's direction) established the fact that starch and glycogen are more or less completely changed into sugar whenever, at a temperature between 30° and 40° C., red blood globules, suspended in a solution of these substances, are destroyed. The result is the same by whatever process the globules are destroyed. Whether the hæmoglobine or the stroma of the globules is the active agent in producing this change is an open question. The theory that a process of this sort goes on normally in the liver derives support from the known solvent action of the biliary salts on the red blood globules, and also from the fact demonstrated by Tiegel that the *post-mortem* change of glycogen into sugar does not take place when the liver has been entirely deprived of blood.

Bock and Hoffmann found that diabetes could be produced by the injection of a one per cent. solution of common salt into the blood of animals. The experiments lasted from five to ten hours, and the injections were made at the rate of about 30 cubic centimetres every

five minutes. The first effect was to increase the amount of urine, and not long afterwards sugar made its appearance. After several hours, the urine was again excreted free from sugar, and if the animal was killed at this period the liver was found to be destitute of glycogen and sugar. If, on the other hand, the animal died while excreting sugar in the urine the liver was found to contain always sugar and sometimes glycogen. A pretty direct connection between the sugar of the liver and that excreted in the urine seems, therefore, to be evident. Unfortunately, these experiments throw very little light on the pathology of diabetes, for the dilution of the blood plasma, the increased blood tension and the irritation of nervous centres by the injected fluid are all possible causes of the passage of sugar into the urine, to decide between which further experiments are necessary.

Lymph.

Dybkowsky.—Ueber Aufsaugung und Absonderung der Pleura-wand. Arbeiten aus der physiologischen Anstalt zu Leipzig, 1 Jahrgang, p. 40.

Ludwig and Schweigger Seidel.—Ueber das Centrum tendineum des Zwerchfelles; do. do. 1 Jahrgang, p. 174.

Genersich.—Die Aufnahme der Lymphe durch die Schnen und Fascien der Skeletmuskeln; do. do. 5 Jahrgang, p. 53.

Lesser.—Eine Methode um grosse Lymphmengen vom lebenden Hunde zu gewinnen; do. do. 6 Jahrgang, p. 94.

Hammarsten.—Ueber die Gase der Hundelymphe; do. do. 6 Jahrgang, p. 121.

Heller.—Ueber selbständige rhythmische Contractionen der Lymphgefässe bei Saügetheiren. Centralblatt für Med. Wiss., July 31, 1869.

Vulpian.—Sur les contractions rhythmiques des vaisseaux lymphatiques. Archives de Physiologie, ii. 779.

Goltz.—Ueber den Enfluss der Nervencentren auf die Aufsaugung. Pflüger's Archiv, v. p. 53.

Nasse.—Untersuchungen über die Einflüsse, welche die Lymphbildung beherrschen. Marburg, 1871.

The lymph spaces which have been demonstrated in nearly all the organs and tissues of the body seem, in certain regions, to play an important part in the absorption and circulation of the lymph. Dybkowsky discovered lymph spaces between the costal pleura and the intercostal muscles, and proved their connection on the one side with the pleural cavity through openings between the epithelial cells, and on the other with the lymphatic vessels. He also showed that, owing to the anatomical disposition of the parts, contraction of the intercostal muscles must dilate the lymph spaces, while relaxation of the same muscles allows them to contract. In the movements of respiration, therefore, the fluids of the pleural cavity are sucked into these spaces and then passed on into the lymphatic vessels. The valves of the latter, of course, prevent a flow in the opposite direction.

A similar arrangement has been shown by Ludwig and Schweigger Seidel to exist in the tendinous centre of the diaphragm. Here the lymph spaces which lie between the tendinous fibres open on the one side into the abdominal cavity and on the other into the lymphatic vessels of the thorax. The rhythmical movements of the diaphragm in respiration, alternately contracting and dilating the lymph spaces,

tend, therefore, to remove fluids from the abdominal cavity and to transfer them to the lymphatic system. This may be shown as follows: A rabbit is cut in halves just below the diaphragm, and the anterior half suspended head downwards. The abdominal cavity is then filled with a colored fluid, e. g. a solution of Prussian blue. The lungs are then rhythmically inflated as in artificial respiration. After a short time the colored fluid will be found to have filled the lymph spaces of the diaphragm and to have entered the lymph vessels beyond.

Genersich showed that the lymph spaces in the fasciæ of muscles may be easily injected from the side towards the muscle, while the lymph vessels arise on the opposite side. This suggested the probability that fasciæ might, when alternately stretched and relaxed, tend to remove fluids from the muscles in the same way that the tendinous centre of the diaphragm removes them from the abdomen. This was shown to be the case by experiments which consisted in conducting a stream of defibrinated blood through the hind-quarters of an animal, and collecting the lymph as it flowed from the thoracic duct. As long as the limbs remained in repose the lymph flowed very slowly from the thoracic duct, but when the muscles were caused to contract by electrical stimulation the flow of lymph was much increased. Passive movements of the limbs, i. e. alternate flexion and extension of the legs, caused a still more decided increase. The amounts of lymph flowing in a given time from the thoracic duct during repose, during electrical stimulation and during passive movement, were found to be related to each other on an average as the numbers 1, 10.6 and 28·9. This would seem to indicate that the active contraction of the muscles is less important for the flow of the lymph than the passive stretching and relaxation of the fasciæ and tendons. We may, perhaps, find in this function of the fasciæ the rationale of those methods of treatment which consist in passive movements, rubbing and kneading of the limbs, &c.

Lesser experimented on dogs curarized and kept alive by artificial respiration. He confirmed the observations af Genersich on the effect of passive movements in increasing the flow of lymph, and found that in general the lymph flowed most abundantly when the blood pressure was lowest. This would seem to indicate that a dilated condition of the bloodvessels favors the production of lymph. This is in accordance with the observations of Gianuzzi* on an increased secretion of saliva, accompanied by dilatation of the bloodvessels and greater flow of lymph as the result of irritation of the chorda tympani.

This view is also sustained by the experiments of Nasse, who found that lowered blood pressure, produced by bleeding, caused for a time an increased flow of lymph, while irritation of the sympathetic nerve diminished the flow. He found, however, that increased blood pressure caused by irritation of a sensitive nerve was accompanied by an increased secretion of lymph.

Hammarsten analyzed the gases of the lymph, finding mere traces of oxygen, but from 28 to 40 per cent. in volume of carbonic acid. In an animal killed by asphyxia the blood was found richer than the lymph in carbonic acid, but this does not prove, as it might seem

* Von den Folgen des beschlennigten Blatstoms für die Absouderung des Speichels. Berichte der K. S. Gesell. der Wissenchaften, Nov. 27th, 1865.

to at first sight, that the greater part of the carbonic acid is not formed in the tissues, but in the blood, for the amount of carbonic acid contained in alkaline fluids depends on the amount of substances capable of combining with carbonic acid which are present in those fluids.

Heller observed in the mesentery of guinea pigs, made insensible with chloroform, a rhythmical contraction of the lymphatic vessels, occurring about ten times in a minute, and causing a rapid propulsion of the lymph contained in them. These observations were repeated and confirmed by Vulpian.

In the experiments of Goltz two frogs were curarized and hung up by the head. In one of them (A) the brain and spinal cord were destroyed, and in the other (B) they were uninjured. On cutting the aorta, no blood flowed from A, but about one or two c.c. from B. A measured quantity of a one per cent. solution of common salt was then placed in the dorsal lymph sac of each frog. In A the fluid remained unabsorbed in the lymph sac, while in B it was rapidly absorbed and flowed from the aorta. The rapidity of absorption was increased by electrical irritation of the legs and diminished by rapid blows upon the abdomen, which operations respectively excite and inhibit the vaso-motor centre. It is, however, not easy to explain the above phenomena on the supposition that the vaso-motor system alone is concerned, and Goltz is inclined to regard the whole body as a sort of gland whose secretion is the lymph, and whose functional activity is regulated by the nervous system, in the same way that the submaxillary gland secretes under the influence of the chorda tympani. In this connection are to be mentioned the experiments which show that after destruction of the spinal cord it is impossible to keep the bloodvessels sufficiently full to insure the regular action of the heart, for artificially injected blood diffuses very rapidly into the serous cavities and connective tissue. Is this transudation the result of the diminished thickness of the vascular walls caused by distention of the vessels deprived of their natural tonicity, or does it depend upon the absence of a direct nervous influence which regulates the exchange of fluids between the interior and exterior of the vessels?

Carbonic Oxide in the Blood.

Donders.—Der Chemismus der Athmung ein Dissociations process. Pflüger's Archiv, v. 20.

Zuntz.—Ist Kolenoxyd hæmoglobin eine feste Verbindung? Pflüger's Archiv, v. 584.

The prevailing theory in regard to the toxic action of carbonic oxide is that this gas drives out the oxygen from the blood globules and enters into a firm combination with the hæmoglobine.

According to this view, blood once thoroughly saturated with carbonic oxide is thenceforth incapable of absorbing oxygen from the lungs and conveying it to the tissues. The transfusion of fresh blood is therefore the only means of saving life. If the blood, however, is not entirely saturated with the poisonous gas it is possible that the oxygen still present may suffice to convert the carbonic oxide into carbonic acid, in which form it may be eliminated. This theory rests upon the observations and experiments of Hoppe-Seyler, Bernard, Hermann and others.

Donders has shown that when a stream of oxygen, hydrogen or carbonic acid, is carried through blood saturated with carbonic oxide, the latter gas is gradually driven from its combination with the hæmoglobine. It passes out, moreover, without any previous change into carbonic acid.

Zuntz subjected blood saturated with carbonic oxide to the action of an air-pump and succeeded in extracting the gas entirely, as was shown by the blood giving the single absorption band of reduced hæmoglobine.

These experiments show that the combination of hæmoglobine and carbonic oxide is by no means so stable as was originally supposed, and make it extremely probable that the gas is eliminated as such by the lungs.

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